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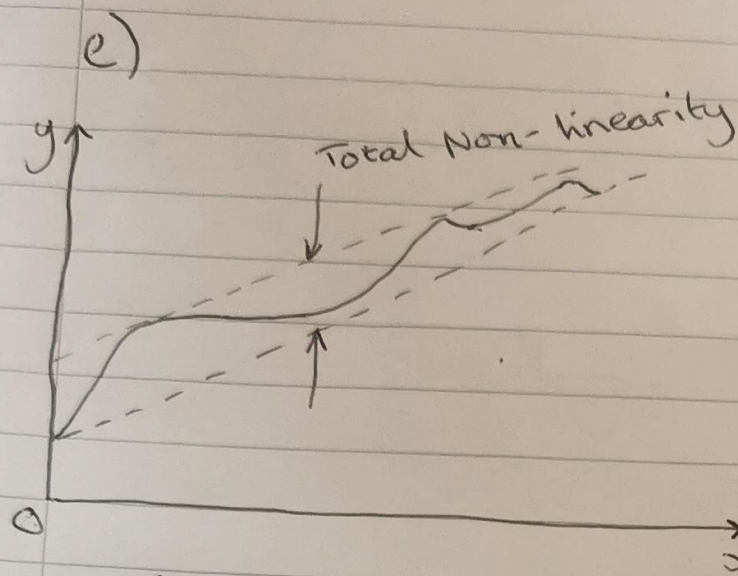
Control Exam 2021

1. a) Measurement is the act of determining the actual traits of something such as dimensions or Capacity. Whereas monitoring is to watch closely in order to observe, record or detect. ~~changes in~~
- b) The two main types of error in measurement are random (chance) errors and systematic (biased) errors. Random errors are usually a result of the experimenter's inability to take the same measurement in exactly the same way in order to get the same result. Systematic errors are ~~reproduct~~ reproducible inaccuracies that are consistently in the same direction
- c) ~~Change in length of gauge~~
A strain gauge is a sensor whose resistance

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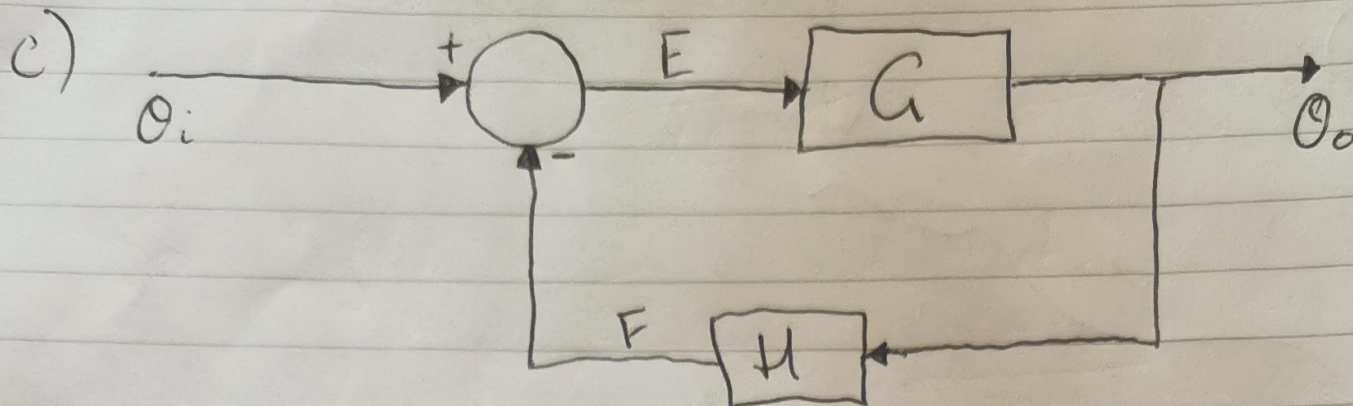
$$\% \text{ linearity} = \left[\frac{\left(\frac{y_{\max}}{2} \right) - y_s}{\left(\frac{y_{\max}}{2} \right)} \right] \times 100\%$$

2. a) An open-loop system has no error signal to account for differences in output value compared to the desired output. i.e. input value. Closed-loop has a feedback signal and measurement system/device as well as comparison element. Closed-loop error is the difference between the

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$$G = \frac{\theta_o}{E} \Rightarrow E = \frac{\theta_o}{G}$$

$$H = \frac{F}{\theta_o} \Rightarrow F = H \cdot \theta_o$$

$$E = \theta_i - F$$

$$\therefore \frac{\theta_o}{G} = \theta_i - H\theta_o \Rightarrow \frac{\theta_o}{G} + H \cdot \theta_o = \theta_i$$

$$\text{So, } \theta_o (1 + GH) = \theta_i \quad \text{hence } \theta_o = \frac{\theta_i}{1 + GH}$$

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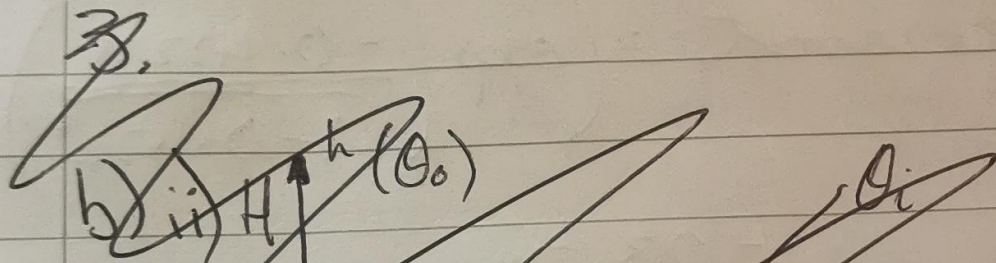
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$$d) \frac{\theta_o}{\theta_i} = \frac{G_1 G_2}{1 + G_1 G_2 H}$$

$$= \frac{(5 \times 0.25)}{1 + (5 \times 0.25 \times 0.15)}$$

$$\therefore \frac{\theta_o}{\theta_i} = 1.053 \text{ mm/v}$$

- e) • Speed control of a conveyor belt
• Temperature control of a brewing process



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4. a) convert a system d.e into standard form; i.e $\frac{d^2x}{dt^2} + \frac{c}{m} \frac{dx}{dt} + \frac{k}{m} x = \frac{F}{m}$

$$\text{So } 2\zeta\omega_n = \frac{c}{m} \quad \text{and} \quad \omega_n^2 = \frac{k}{m}$$

$$\therefore \omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{300}{7.5}} = 6.325 \text{ Hz}$$

$$\text{Now, } \zeta = \frac{c}{2\omega_n m} = \frac{40}{2 \times 6.325 \times 7.5} = 0.422$$

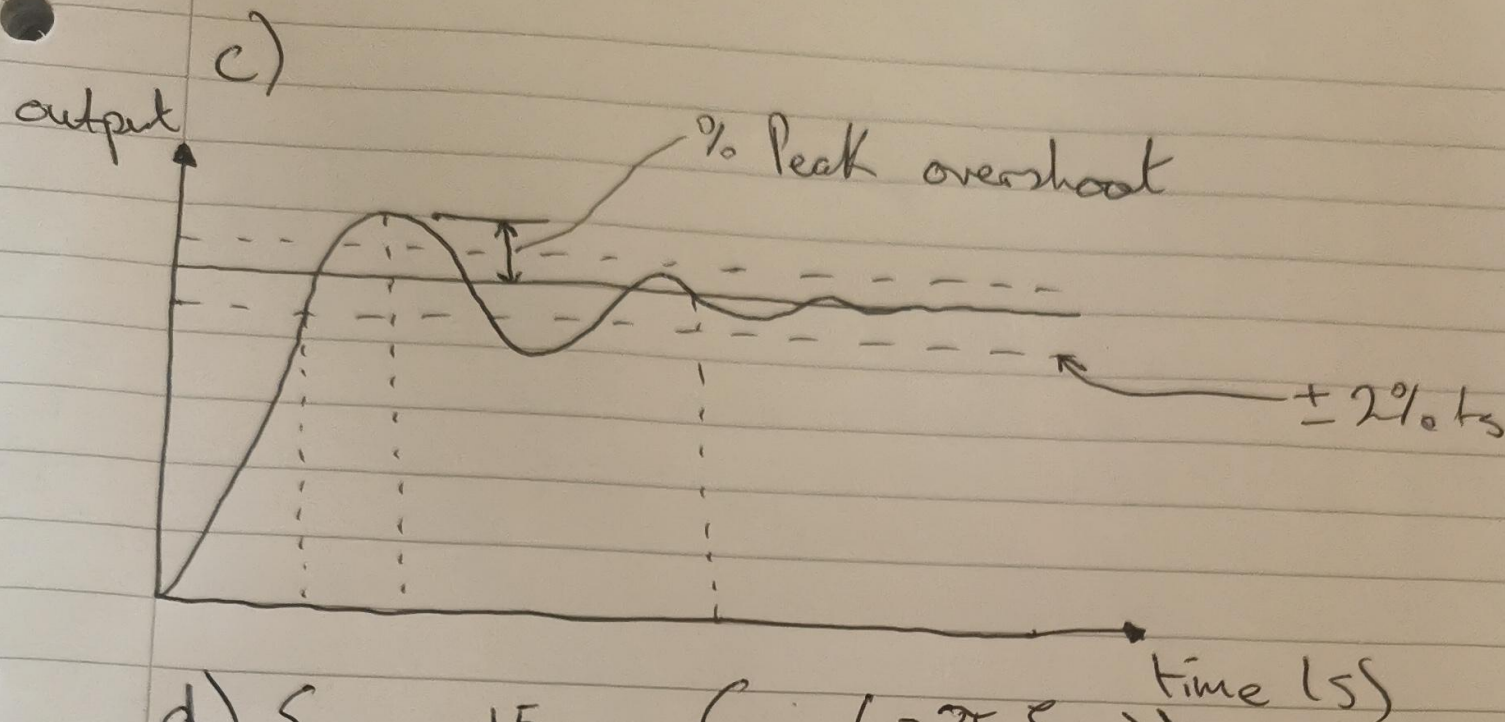
Hence system is underdamped

$$\begin{aligned} \text{b) \% peak overshoot} &= \left(\exp \left(\frac{-0.422\pi}{\sqrt{1-0.422^2}} \right) \right) \times 100\% \\ &= 23.17\% \end{aligned}$$

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d) $S_0 = 15 = \left\{ e^{\left(\frac{-\pi \zeta}{\sqrt{1-\zeta^2}} \right)} \right\} \times 100$

Taking Natural logs of both sides

$$\ln 0.15 = \underline{\underline{-\zeta \pi}}$$